HUMAN FACTORS IN "RAINPUTTO" KEYBOARD FOR KANZI INPUT

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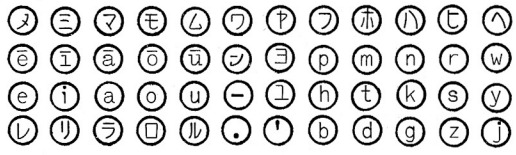
1. The touch typewriting for kanzi input.

A kanzi-kana input device, which can be operated rapidly and accurately, has been desired in Japanese information processing. Most of the kanzi-kana input devices in practical use are the kanzi-teletypewriters, which have several hundred keys on their keyboards. It is impossible to type by "touch" because of their keyboards. And this typewriting is needlessly difficult to master, yet slow, inaccurate, and fatiguing.

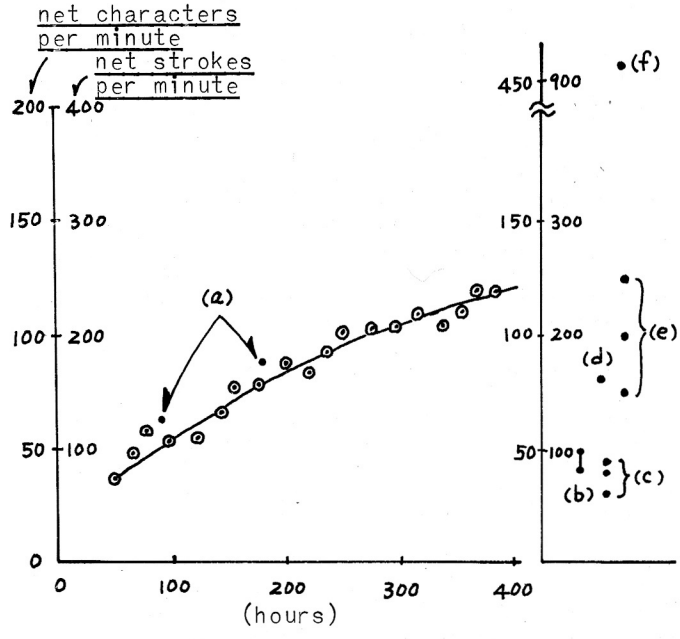
In 19th century, a typewriter could be operated at the then inconceivably dazzling rate of "equal to handwriting". European and American pepole expected that typists would "hunt and peck" with the first finger of each hand. Touch typing and typewriting speed as we know them today were not then even being imagined.

Only a touch typewriting method will be able to answer the desire to type kanzi-kana rapidly. In this point of view, we designed a new kanzi-kana input keyboard (Fig. 1), which can be operated by touch method. We have taught twenty-six persons "rainputto". Fig. 2 is the learning curve illustrating the average attainments in net characters per minute, computed by:

$$\begin{pmatrix}\text{net}\\ \text{characters}\end{pmatrix} = \begin{pmatrix}\text{gross}\\ \text{characters}\end{pmatrix} - (\text{error} \times 5)$$



(Fig. 1) "rainputto" keyboard



(Fig. 2) learning curve

(a) Average high-school attainment on the "universal" typewriter keyboard in America.[1]

(b) An operation speed of the kanzi-teletypewriter.[2]

(c) The 1st grade, the 2nd grade, and the 3rd grade of the Japanese typewriting contest held by the Chamber of Commerce.
(d) Championship score (1971), the 21st Japanese typewriting contest.
(e) The 1st grade, the 2nd grade, and the 3rd grade of the kana typewriting contest held by Nippon Office Management Association.
(f) Lenore Fenton MacLain, "the fastest secretary in the world," is able to type 182 net words a minute on the Dvorak keyboard.

2. What makes a good keyboard ?

Rhythm is the keynote of smoothness, ease, quickness of learning and freedom from error and fatigue in typing, as it is in all human efforts. Those motions which can be accomplished in rhythmical order and sequence are most easily and accurately accomplished, and produce the least fatigue. Rhythm is acquired largely by the alternate stroking in typing, stroking first by one hand and then the other, or if that is not possible, stroking first by one finger and then another finger. Rhythm is advanced by avoiding sequential strokes by the same hand or by adjacent fingers of the same hand, where the same hand must be used in sequence. Above all, it is promoted by so arranging the keys that the sequences which occur naturally and frequently in a language are stroked in so far as possible by the fingers of different hands.

Words are stroked as wholes and a typist is usually unaware of the individual letters. Successful typing is the more or less relaxed following, by the typist, of such sequences (word patterns) with the typewriter. A keyboard arrangement must be based upon the requirement of the sequential stroking, whose even uninterrupted flow we call "rhythm". Counting isolated letter strokes, then, is contrary to the above facts, for typewriting is not a sum of separate tappings by each finger. As an example, consider that if an expart, capable of well beyond one hundred net words a minute, should attempt typing random letter sequence, measurements would show his speed to be absurdly slowed to approximately twenty words a minute. The isolated letter-stroke, thus makes even experts appear ridiculous. Typewriting, like reading, moves not by individual letters, but in word-wholes or phrase-wholes.

Typewriting is a complex process, depending upon all the variables of differing typists, motions, machines, and surroundings. To control variations of typing motions involves keeping delicate balances between tension and relaxation, eliminating unnecessary movements, using the shortest, most direct motion paths, at the least possible energy-cost and feeling-cost. To increase the advantages mechanically that accompany fast motions, takes as few stops and starts as possible. Hence unavoidable finger waits are partly compensated by hovering lightly over keys. Typing motions, moreover, are correct when made in whatever way best fits them together. This is called "play for position". As a finger gets away from a key, the next finger is already in position and stroking. These prompt plays for position and over-lappings between strokes permit faster timing and rhythm, anything, such incorrect or awkward position of the keys in the keyboard, which interrupts or slows down this rhythm, contributes to errors, to slower stroking, and to fatigue.

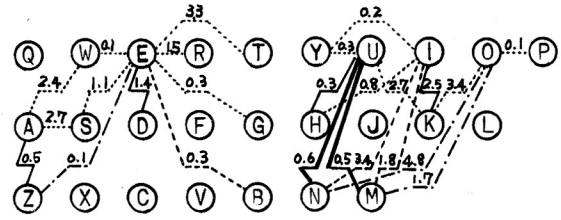
Accordingly, our new kanzi-kana input keyboard version depends upon the study of sequences and of the possibilities for speed and accuracy, gained via the increase of the number of sequences stroked by opposite hands, or by remote fingers.

3. What are the improvements of the "rainputto" keyboard ?

Our study has for its general objectives: (a) making the good rainputto abbreviations for kanzi and kana which are easy to learn, (b) the provision of a systematic arrangement of the keys of a typewriter which will reduce typewriting errors, (c) facilitating increase of operation speed by eliminating awkward stroke sequences, (d) lessening the fatigue of typists based on a better arrangement of the keys for the sequences most frequently used and for the rhythmical flow of sequential strokes, and based on more equitably distributed labor for individual fingers and two hands.

Sequences (a) involving adjacent fingers of the same hand, (b) involving upper and lower banks of keys and fingers of the same hand, or (c) involving the repeated use of the same finger, maybe termed awkward sequences, because their stroking does not fit into the rhythm of the typist so well as other more easily executed sequences, involving different hand, or remote fingers on the same hand. Such awkward sequences are time-comsuming to execute, prone to errors, unduly fatiguing, and detrimental to rhythm. An attempt on reduction of awkward sequences was initiated by August Dvorak for English.(3) In some Japanese rômazi typewriters(4) and Korean typewriters(5) this is also put into practice.

The hiragana characters constitute more than 50% of written Japanese. In "rainputto" each hiragana represented by two strokes of Roman letters. In reference to Fig. 4-(A) the first stroke is for a consonant by the right hand, and second for a vowel by the left. This alternate stroking is well established to be the firstest two-stroke sequence in touch typewriting. We have completely eliminated the awkward stroke sequences in our system, while in comparison if we use the "universal" typewriter keyboard such awkward sequences constitute 36.8% for actual hiragana sentences. Fig. 3 and 4 present diagrammatically some of the data about the "universal" and the "rainputto" keyboards.



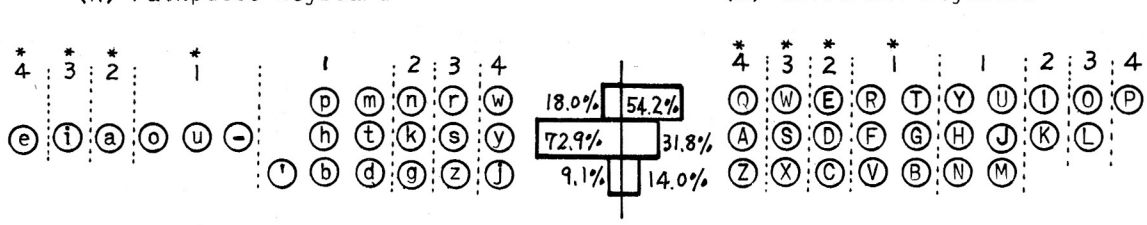
stroking pattern	frequency (%) left hand	right hand	total
same finger:			
hurdles (——)	0.0	1.1	1.1
reaches (——)	1.9	2.8	4.7
adjacent fingers:			
hurdles (-----)	0.3	5.2	5.5
reaches (.....)	11.4	7.5	18.9
remote fingers:			
hurdles (—·—)	0.1	6.5	6.6
total	13.7	23.1	36.8

(Fig. 3) awkward sequences on the "universal" typewriter keyboard for hiragana.

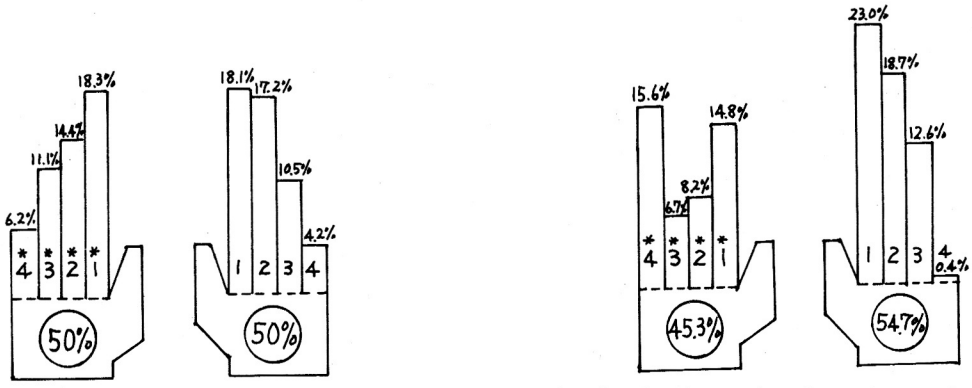
The most frequently used about two thousands kanzi characters are represented by the combination of two strokes. The kanzi abbreviations may be classified into four groups based on (a) pronounciation, (b) meaning, (c) shape, and (d) idiom. Concerning two thousands kanzi characters, we obtained the following data (Table. 1)(Fig. 5).

same finger "hurdles"	5.5 %
"reaches"	8.0 %
adjacent fingers "hurdles"	3.0 %
"reaches"	10.5 %
remote fingers "hurdles"	4.0 %

(Table. 1) Frequency of awkward stroke sequences for kanzi.

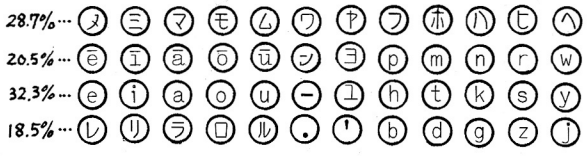


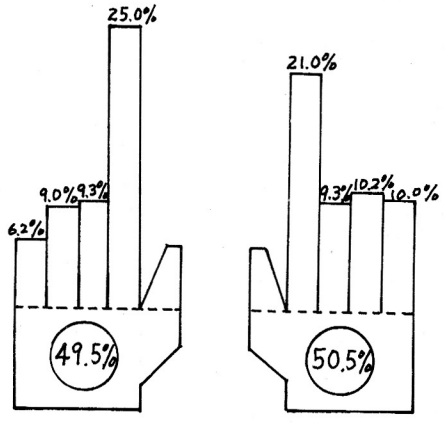
Histogram show the distribution of strokes in each row.



Figures on each hand and length of fingers indicate amount of work performed.

(Fig. 4) Comparative row, hand, and finger typing-loads on the "rainputto" and on the "universal" typewriter keyboards for hiragana.





(Fig. 5) Comparative row, hand, and finger typing-loads on the "rainputto" for kanzi.

4. A new keyboard for Chinese.

We have also designed a new keyboard for Chinese using the similar principle.

References:

(1)(3) A. Dvorak, " Typewriting behavior", American Book Co., 1936, 521pp.

(2) H.Huwa, and M.Nisino, "Automatic compilation system of abstructs journal", Zyôhô kanri, vol. 12 no. 6, p.293-308, September 1969.

(4) A.Kawakami, "A new keyboard for rômazi", Rômazi sekai, August, September 1952.

(5) Y.Usui, "Korean typewriter", Kana no hikari, vol. 598, p.13-15, June 1972.